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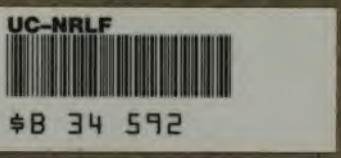

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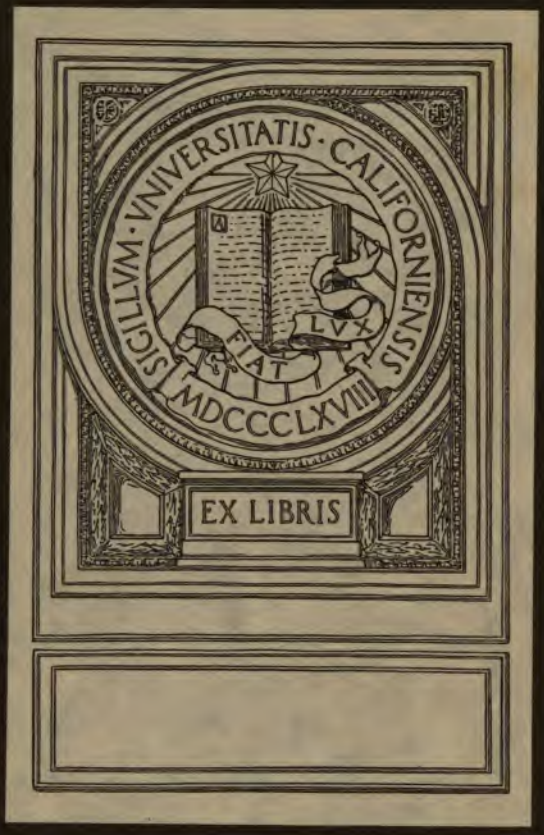

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Uncle Sam's Farm.

THE RECLAMATION

OF THE

ARID REGION

OF THE UNITED STATES

BY MEANS OF

IRRIGATION.

From Frank Leslie's Illustrated Newspaper of November 16th, November 23d, November 30th, and December 7th, 1889.

THANKSGIVING SERIES OF 1889.

BY

JOSEPH NIMMO, Jr.

WASHINGTON:
GIBSON BROS., PRINTERS AND BOOKBINDERS.
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ACKNOWLEDGMENTS.

I desire to express my obligations, for recent information and assistance, to Hon. Francis E. Warren, Governor of Wyoming; Hon. L. Bradford Prince, Governor of New Mexico; Hon. Geo. L. Shoup, Governor of Idaho; Hon. Arthur L. Thomas, Governor of Utah; Hon. Joseph M. Carey, Delegate in Congress from Wyoming; Hon. W. M. Stone, Acting Commissioner of the General Land Office, the Acting Commissioner of Indian Affairs; Mr. Henry Gannett, E. M., Geographer of the 10th and 11th Censuses; Mr. A. N. Towne, Third Vice-President and General Manager of the Southern Pacific Co.; Hon. Wm. Ireland, Jr., State Engineer of California; Hon. Elwood Mead, Territorial Engineer of Wyoming; Prof. L. E. Hicks, of the University of Nebraska, also Geologist and Director of the Experiment Station of Nebraska; Mr. C. W. Foul, Secretary of the Farmers' Canal Co., of Collins, Nebraska; Mr. Chas. L. Johnson, Private Secretary to the Governor of Colorado.

I also bear in grateful remembrance the courteous attentions and valuable assistance which I received from hundreds of intelligent men, engaged in various walks of life, throughout the States and Territories of the arid region, while I was engaged in investigating the resources and capabilities of that vast area during the years 1885 and 1886.

JOSEPH NIMMO, JR.

HUNTINGTON, LONG ISLAND, N. Y.

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Introductory Announcement from Frank Leslie's Illustrated Newspaper of Nov. 9, 1889.

OUR THANKSGIVING SERIES.—UNCLE SAM'S FARM.

Three years hence we shall celebrate the four hundredth anniversary of the discovery of America. But the process of discovery on this continent has been going on ever since the shores of San Salvador first met the anxious gaze of Christopher Columbus. During the last ten years the discovery has been made that the vast arid region of the United States, comprising four-tenths of the national domain exclusive of Alaska, is susceptible of reclamation by means of irrigation. It is, however, only within the last year that the National Government has awakened to the importance of this wonderful discovery. Soon Congress and the country will be enlightened by the results of the investigations which have been carried on during the last six months by the Geological Survey, and by a select committee of the United States Senate, appointed for the purpose of ascertaining what course the Government ought to pursue in regard to the matter. Appreciating the importance of the subject, "Frank Leslie's Illustrated Newspaper" resolved to present a series of four articles in regard to it by a specialist, as a Thanksgiving series, the first of which will appear next week. For this task Mr. Joseph Nimmo, Jr., formerly Chief of the Bureau of Statistics at Washington, was selected. As an officer of the Government, Mr. Nimmo carefully studied and reported upon the whole subject of the commercial and transportation interests of the arid region, and in 1885, in compliance with a resolution of the House of Representatives, he prepared a report on the "Range and Cattle Business of the United States," which report threw a flood of light upon the resources of that section of the country. Since he retired from public office Mr. Nimmo has spent six months in the Arid Region, diligently investigating its resources and possibilities. His professional knowledge as a civil engineer has also, in an especial manner, fitted him for such an investigation and for the task of writing in regard to the important development which will undoubtedly be realized by means of a thorough and scientific scheme of irrigation.

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UNCLE SAM'S FARM.

By JOSEPH NIMMO, Jr.

The title of this article was suggested by the editor of *Frank Leslie's Illustrated Newspaper*. It is felicitous for the reason that it is suggestive of a wealth of land still awaiting culture, under a wise and beneficent public policy, which has already secured homes to millions dependent for living upon the products of the soil.

Since independence was achieved the United States Government has been the largest owner of arable land on the earth. The total area of the "public domain," sold and unsold, amounts to 1,849,072,587 acres, and constitutes seventy-two per cent. of the total area of the United States, including Alaska. About 700,000,000 acres of land have been sold and donated, about 1,150,000,000 acres remain unsold. As the area of Alaska is 369,530,000 acres, the area unsold exclusive of that Territory is about 780,000,000 acres.

This vast landed estate was acquired by the War of Independence, by the purchase from France in 1803 of the enormous area known as the Province of Louisiana, extending from the Mississippi River to the Pacific Ocean; by the purchase of Florida from Spain in 1821, by the treaty of peace with Mexico in 1848, and the supplemental treaty of 1853, which gave us California and brought our southern border line down from Oregon to where it is now; by purchase of border lands from Texas in 1850, and by the purchase of Alaska from Russia in the year 1867. The cost of the public domain for purchase, quieting Indian occupancy titles, surveys, and sale has been 17⅞ cents per acre. The prices at which the public lands have been sold has ranged from 12½ cents to $2.50 per acre for agricultural lands; $2.50 to $5 per acre for mineral lands—except coal lands, which are sold at $10 and $20 per acre, according to location with respect to land-grant railroads. The Governmental balance sheet on account of public lands on the 30th of June, 1889, stood thus:

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Expenditures:	
For purchases and cessions.....	$88,157,390
For surveying and sale.....	46,663,302
For Indian occupancy title, etc.*....	187,328,904
Total.....	$322,149,596
Receipts:	
From sale of lands, etc.....	$299,547,818
Expenditures in excess of receipts....	22,601,778

This excess of expenditures, however, is greatly overbalanced by the 780,000,000 acres of land, exclusive of Alaska, still in the possession of the Government. The value of the remaining part of the public domain is estimated at from $800,000,000 to $1,000,000,000. If all these lands, or the proceeds from their sale in excess of the present balance against the Government, shall be appropriated to the reclamation of the arid region by means of irrigation, such action will be quite in harmony with the policy pursued by the National Government from the beginning, viz: to regard the public lands not as a source of revenue, but simply as a public trust, with the object steadily in view of transferring them to actual settlers at the lowest possible cost, and as rapidly as may be consistent with a healthy national development. No political party has swerved from this wise and beneficent policy, and no Administration of the National Government has been false to this great trust.

In our "Homestead," "Pre-emption," "Tree-culture," and "Desert-land" laws—the most humane and beneficent features of all our public land legislation—the poor frontiersman has been accorded a vantage and a protection which have guarded him against the encroachments of influence and of wealth. Our public-land policy has also been just and generous toward the Indians, paternal and kindly toward the soldier and sailor, and always honest and upright toward the public interests.

For the erection and sustentation of schools, seminaries, and agricultural colleges, the magnificent donation of 78,786,794 acres of land has been made. There has been granted to the States, for public improvements, 7,810,556 acres of land. One of the

* Corrected to June 30, 1880.

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wisest, and in its results beneficent, features of our land policy has been the granting of about 51,800,046 acres of the public lands for the construction of wagon-roads, canals, and railroads, and chiefly the latter. Within certain limits the Government has given half the land in alternate sections to railroad companies; but at the same time it has doubled the price of its remaining lands within such limits. No other expedient has so effectually tended to promote settlement, or to secure the development of the resources of the country, and especially of that vast area toward which the attention of the country is now turned with such deep interest—the "arid region." At the same time it is the intelligent and well-considered verdict of the American people that the policy of land-grants went about far enough.

The conduct of our public-land interests is a crowning glory of American statesmanship and an abiding honor to the administration of our national affairs. In a world in which every forceful man is seeking his own, it is a record which illuminates our civilization. There have been heated disputations at times in regard to methods of administration and matters of detail touching the guardianship and disposition of our public lands, but no political party line has ever been drawn on any of these questions, and there appears to be no sensible excuse for such action in the future.

The method of dividing the public lands into townships six miles square, and numbering the square miles or "sections" of each township in the same uniform manner from one to thirty-six, was devised during the period when our National Government was a confederacy. The bill which enacted it is dated May 20, 1785. It was reported by a committee, of which Thomas Jefferson was chairman.

Such, briefly, are some of the more important historical facts in regard to "Uncle Sam's Farm." And now let us turn from the past to the present and the future. Questions of great moment touching matters of administration and of public policy confront us, and demand solution at the hands of the generation which now controls the destinies of the nation.

THE HUMID AND THE ARID REGION.

The national domain is divided by nature into two distinct areas, designated as the "Humid Region" and the "Arid Region." The

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former embraces all lands upon which agriculture may be carried on by means of the natural rain-fall, and the latter the area in which agriculture can be successfully prosecuted only by means of artificial irrigation. The physical characteristics of the arid region affect the national economy in important particulars, and constitute conditions which demand certain modifications of our public-land policy.

Practically, the Government has disposed of all lands of any value within the humid region. This has given pause to westward immigration. The restraint which the arid region has imposed upon settlement was recently illustrated by the rush of immigration into Oklahoma, a portion of the Indian Territory well within the limits of the humid area. In the remainder of these articles attention will be invited exclusively to that portion of "Uncle Sam's Farm" which lies west of the 100th meridian, *i. e.*, the arid region.

THE ARID REGION.

The arid region of the United States, delineated on the map at the end of this pamphlet, extends from about the 100th meridian of west longitude to the Sierra Nevada range and the Pacific Ocean. Approximately its dimensions are 1,200 miles from north to south and 1,300 miles from east to west. It contains, in round numbers, ONE THOUSAND MILLION ACRES OF LAND. According to Major John W. Powell, Director of the Geological Survey, it embraces about four-tenths of the total area of the United States, exclusive of Alaska.

For many years the arid region was known as the "Great American Desert." This designation, with respect to one characteristic, was apparently correct—its rain-fall is not sufficient for the needs of agriculture. But in other important particulars it is glaringly incorrect and misleading. Throughout this area, and suited to its conditions, Nature, out of her fecundity, has planted a variety of highly nutritious grasses, which cure in the open air and retain their nutritious properties through the storms and atmospheric changes of two and even three years. No hay gathered into barns is so well preserved. The principal grasses of the arid region are buffalo grass (*Buchloe dactyloides*), gramma grass (*Bouteloua oligostachya*), and "bunch grass" of various species. When these fail, animals have recourse to sage-brush

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and grease-wood (*Sarcobatus vermiculatus*), and the shrubs which grow along the borders of streams. For untold centuries these grasses, herbs, and shrubs afforded abundant pasturage for millions of buffaloes, elk, noose, deer, and other graminivorous animals.

In another important particular the designation "Great American Desert" is glaringly incorrect. The lands of the arid region become surpassingly productive when irrigated by turning water upon them from the rivers and smaller streams. A given amount of labor and capital expended in agricultural pursuits in the arid region will, by means of irrigation, produce much larger results than in the rain-fall area. This is an economic and commercial fact of the highest importance. Large portions of the arid region, however, cannot be irrigated, and for all time will be of value only as pasturage. Other extensive areas, embracing the more mountainous areas, are valuable only as forests.

PASTORAL INTERESTS OF THE ARID REGION.

Until about twenty years ago the arid region remained the hunting-ground of Indians, who during the summer months were permitted to leave their reservations and engage in their favorite avocation—the chase. But a change came of momentous consequence to the whole country. It was discovered that the nutritious grasses of the arid region, which cure so perfectly in the open air, are available for the raising of domestic animals with no care save that of herding. Late in the fall of 1864 a wagon-train hauled by oxen was on its way to a military post in Utah. Its progress was arrested on the Laramie Plains by a severe snow-storm, which compelled the people in charge to go into winter quarters. Their oxen were turned loose to die, but instead of perishing with hunger during the winter months, they grew fat upon the abundant nutritious grasses—nature's hay—which covered the hills and the valleys. The knowledge of this fact soon spread.

At this time there were in Texas millions of young cattle worth only from four to five dollars a head, about the value of their hides and tongues. Hundreds of thousands, and even millions, of these were driven north in vast herds. Young cattle were

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also brought in from the east and from the west, and within ten years the ranges of the arid region were stocked from Texas to Montana. Thus the buffaloes were expelled from their former grazing-grounds, while hundreds of thousands of them were killed for their hides. If no American or foreign hunter had ever visited the arid region the expulsion of the buffaloes would have been as certain and about as rapid as it was. The moose, the elk, and the deer also retreated to mountain fastnesses, and in a marvelously short period of time the Indian's occupation as a hunter was forever gone. Besides, the Texas cow-boy, accustomed to fierce encounters and a born enemy to the Indian, held him close corraled upon his reservation.

The quality of range beef has improved considerably by crossing the "native" and Texas cows with graded or full-blooded bulls of the Hereford, Polled Angus, Galloway, and Short-horn breeds. Besides, it has been found that young Texas cattle attain a greater weight on the northern ranges than if held in Texas. Sheep husbandry has been successfully introduced into all parts of the arid region. The losses among sheep on accoont of severe and protracted winter storms are much less than among cattle. The wool product of the arid region is of fine quality, and is constantly improving by the care taken of the sheep during the winter months and by judicious breeding. The total wool product of the arid region in 1887 was about 140,000,000 pounds, and constituted fifty per cent. of the total wool product of the United States.

Raising horses "on the range" has also become a large and profitable industry, especially in Wyoming, Utah, and Idaho. The climate of the arid region develops in horses excellent lung power, and the conditions of food and climate produce strong bones and hoofs. Imported stock for breeding purposes has been extensively introduced of the Norman-Percheron, the Clydesdale, Kentucky thoroughbred, and other fine strains of horses. Both the roadsters and work horses of the arid region command high prices in eastern markets. There are now within the limits of the arid region about 12,000,000 cattle, 18,000,000 sheep, and 1,500,000 horses. The sale of the annual surplus product of cattle, horses, and wool alone has created a large and profitable commerce.

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The raising of horses, cattle, and sheep on the range is carried on chiefly upon the public lands of the United States, for the United States Government has always allowed its public lands to be used as a common pasturage. The herdsmen usually preempt and purchase land along streams, which are essential for watering domestic animals, and furnish merely the nucleus of their herding operations.

For a while the opinion was generally entertained that the arid region is available only for pasturage, and that it must be forever treated as such. But this opinion is now seen to be entirely erroneous. Another great change is taking place; it has been proved that by means of irrigation the lands of that vast area are susceptible of an enormous and splendid agricultural development, and the result is that the cow-boy has been forced to the confession that "when the man with the plow comes, the man with the spurs has got to get out." Neither the savage nor the nomad can resist the forces of civilization. The severe winter losses, the failure of the supply of natural grasses on the ranges through overstocking them, the high price of young cattle in Texas, and low price of beef cattle in Chicago, have led to the conviction that henceforth pastoral pursuits must be carried on chiefly as adjuncts of agriculture. The economies all point in that direction.

This change in the condition of affairs summons the nation to the consideration of such problems of development as have confronted the countries of Asia, Africa, and southern Europe in all ages—problems the solution of which depends upon the establishment of a wise and beneficent system of irrigation.

IRRIGATION OF ARID AGRICULTURAL LANDS.

From the earliest ages, very much the larger part of the human family has been dependent for food upon the product of irrigated lands. But such has not been the case on this continent. The early settlers, and for many years almost all the immigrants to this country, came from Great Britain and Ireland, and from the countries of northern Europe which have an abundant, and to some extent a superabundant, rain-fall. Besides, our ancestors landed here, upon the eastern shores of by far the largest area on

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the earth's surface within which agriculture is possible without artificial irrigation; an area extending from the Atlantic seaboard to about the 100th meridian. This meridian passes through western Dakota, Nebraska, and Kansas. Thus the United States grew to be a great nation with irrigation practically a lost art. As the tide of immigration rolled westward the border-land of the great arid region was at last reached. Here nature seemed to call a halt. But the indomitable spirit of adventure and the wild fascination of gold and silver mining led the more adventurous to invade even that vast and inhospitable region. Soon the brave frontiersmen who composed this host of fortune-seekers were driven by the sheer force of circumstance to agriculture by irrigation. Thus a wealth of soil was discovered far in excess of the wealth of mine, and within the last year the important fact has dawned upon the country that the reclamation of the agricultural lands of the arid region opens up the last, and perhaps the most important, chapter in the history of the subjugation of wild lands to the uses of civilized man upon this continent.

The area of agricultural lands susceptible of reclamation by means of irrigation is variously estimated at from 125,000,000 to 200,000,000 acres. Even 125,000,000 acres is sufficient for the agricultural area of a mighty empire. It is nine times the area of the improved land in farms of Pennsylvania, eight times that of New York, and sixty per cent. more than that of all the New England States, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida combined. But every acre of irrigated land is about twice as productive as lands dependent upon the natural rain-fall. This has been demonstrated beyond all doubt by thousands of brave settlers who, under the provisions of our Desert Land Law, have already reclaimed about 7,000,000 acres of land by means of irrigation.

The great practical question which now confronts the country is, How can we, by a large and comprehensive scheme of irrigation, reclaim from 120,000,000 to 200,000,000 acres more of this vast region? Happily we are not left to the uncertain results of tentative enterprise in the attempt to solve this great problem of the age, for it has been solved again and again in other countries,

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and under natural conditions quite similar to those which characterize the arid region of the United States.

Let us attend to some of these lessons.

WHAT THE NATIONS OF ANTIQUITY ACCOMPLISHED THROUGH IRRIGATION, AND WHAT IS NOW BEING ACCOMPLISHED BY THIS MEANS IN OTHER COUNTRIES.

The branch of hydraulic engineering which relates to the construction of irrigating works dates back to the prehistoric ages of antiquity. Babylonia and Assyria were intersected by a system of canals which answered the twofold purpose of irrigation and navigation. One of the canals of Babylonia is said to have been 600 feet wide and 1,000 miles long, constituting a great artificial river. It served to reclaim an area of imperial dimensions. The canal of the Pharaohs, which connected Pelusium with the Red Sea, was an irrigating canal. China, and India, and Ceylon, and Arabia, and Egypt, and, in fact, the entire Orient, are full of irrigating works and the ruins of such works.

When the British conquered India they found innumerable canals and reservoirs for irrigation. One province, the "Madras Presidency," had fifty-three thousand reservoirs, formed by thirty thousand miles of embankment, and having three hundred thousand masonry gates, sluices, waste-wiers, etc. With a total area only about three-fourths the size of our "arid region," and dependent almost entirely upon irrigation, India supports a population of two hundred millions. Throughout large portions of that country the storm waters which fall during a brief season of the year are stored in tanks or cisterns, and thus become available for irrigation. The British government has expended nearly four hundred million dollars in the improvement and extension of irrigating works in that country. The great Ganges canal is nearly 1,000 miles long, and carries 7,000 cubic feet of water per second. It irrigates over 2,000,000 acres of land.

The great canal of Arabia, which irrigated the valley of Mareb, proceeded from an immense reservoir, formed by a dam two miles long and 120 feet high, in the province of Yemen. This dam was constructed of huge blocks of dressed stone and stood for two thousand years. These works existed long before the days of

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Solomon, and by some writers are assumed to have excelled all works of the kind, ancient or modern, indicating the skill of the Arabians as mathematicians and engineers.

Palestine was irrigated chiefly by means of wells, reservoirs, and tanks. Similar methods are now employed throughout Turkey and Asia Minor.

The great irrigating systems of antiquity constructed by wealthy and powerful nations have gone to ruin, and the countries which they reclaimed from the desert are in decay, for the reason that since their fall there has been no government strong enough or intelligent enough, or with jurisdiction large enough, to restore and maintain such extensive engineering works.

A clear understanding of the fact that the countries of the Orient are dependent upon agriculture by means of irrigation, serves to throw much light upon Scriptural references to those countries, and gives a larger significance to the divine mandate—"Subdue the earth."

The Prophet Jeremiah evidently refers to the vast irrigating system of Babylonia in the words "O thou that dwellest upon many waters, abundant in treasures" (Jer. li, 13). The entire disappearance of her "many waters," *i. e.*, irrigating works, constitutes the overshadowing cause of the utter destruction of "Babylon, the glory of Kingdoms, the beauty of the Chaldees' excellency." This fact appears to be clearly stated by Jeremiah in the words, "A drought is upon her waters and they shall be dried up;" and again, "Her cities are a desolation, a dry land, and a wilderness" (Jer. l, 38). The Prophet Zephaniah appears also to have had reference to the historic fact as to the destruction of the irrigating works of Nineveh in the passage, "He * * * will make Nineveh a desolation and dry like a wilderness" (Zeph. ii, 13).

The fact that these mighty nations of Asia were absolutely ruined by the catastrophe involved in the destruction of their irrigating works fully explains the fact that their people have exhibited less persistency than those inhabiting countries in which the rainfall is adequate to the needs of agriculture, where, of course, no such overwhelming catastrophe as the absolute failure of agriculture could occur. When the irrigating systems of these mighty empires were gone, all was lost.

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The Moors constructed extensive irrigating works in Spain a thousand years ago, and agriculture is there still carried on by the same means and under substantially similar government regulations. The ancient Peruvians and Mexicans constructed immense aqueducts for irrigation long before the conquest of their respective countries by the Spaniards. Agriculture throughout Mexico is dependent upon irrigation. Recent explorers in Arizona have traced irrigating canals and reservoirs of considerable magnitude, and the remains of adjacent towns and cities indicating a population of at least 300,000 where now is a desert. The present population of Arizona is only about 85,000.

France has expended enormous sums of money in Africa upon the irrigating works of her Algerian possessions, and with excellent result. The art of irrigation is also practised extensively in the southern part of France.

Lombardy and Piedmont in Italy take the lead in the irrigating works of southern Europe. The art of irrigation has come down to Italy from the Romans, who built extensive irrigating canals and reservoirs. The length of the irrigating canals of Lombardy has been doubled during the last thirty years. A fact especially worthy of note is that Lombardy and Piedmont have a rainfall of 37 to 38 inches annually, agriculture being there possible without irrigation, nevertheless irrigation is practised for the reason that it greatly increases the volume of the crops, and also serves to insure them against destructive droughts, which sometimes occur. This furnishes a very important practical lesson to the people living in what Major Powell styles the Sub-Humid Region of the United States, *i. e.*, the region between a line where the rainfall is less than 28 inches annually, and the positively arid region, in which agriculture is possible only by means of irrigation.

At last the people of this country are fully awake to the fact that they must grapple with conditions in the arid region similar to those which have been boldly met and successfully overcome by the nations of antiquity and by nations of the present day in Asia, Africa, and southern Europe. Such achievement clearly opens up to us as a nation a grand development and a splendid future.

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WHAT HAS BEEN DONE FOR THE RECLAMATION OF ARID LANDS IN THE UNITED STATES.

Aside from the practise of irrigation in Arizona in ancient times, and in New Mexico by the natives of that country during the last three hundred years, the earliest attempts at irrigation in this country were made in California and in Utah between the years 1847 and 1850, and later in Colorado, Wyoming, Idaho, Montana, and Arizona. These beginnings, as before stated, were the result of the compulsion of circumstance rather than of any intelligent scheme of development. For the most part such efforts were tentative, and absolutely empirical, exhibiting less knowledge of hydraulic engineering than was possessed by the Arabians 4,000 years ago. But as the enormous possibilities of irrigation were developed, engineering ability of the highest order has been secured throughout the arid region. In California, in Colorado, in Wyoming, and elsewhere, the construction of irrigating works, and the supervision and direction of such enterprises, is now in the hands of hydraulic engineers eminent in their profession. Thus about 7,000,000 acres of land in various parts of the arid region have already been reclaimed.

It is stated by William Hammond Hall, State Engineer of California, that not more than one-sixth of the tillable land in that State can sustain a really dense population without irrigation. Many million dollars have been expended already upon irrigating works, and thereby 2,500,000 acres of land have been or may be reclaimed. A State survey, designed to show completely what has been done and what may yet be done, is now in progress, but it is not sufficiently advanced in order that its results may be summarized.

Arizona has already 200 miles of irrigating canals and ditches, by means of which about 300,000 acres of land have been reclaimed, at a cost of about $3,000,000. The total irrigable area of the Territory is now estimated at 2,000,000 acres.

In New Mexico irrigation has long been practical as an old Mexican and Spanish art. Works of considerable magnitude are now projected or in progress on the Rio Grande and Picos rivers, the former providing for the reclamation of from 3,000,000 to 4,000,000 acres of land. It is estimated that a sufficient supply of water can be secured from streams and stored in reservoirs

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for the reclamation of a large portion of the 60,000,000 acres of agricultural lands in New Mexico, including a considerable part of the waterless and treeless tract known as the "*Llano Estacado*" or "Staked Plains."

In Colorado there are now 800 miles of irrigating canals of large size, and 3,500 of secondary size—a total of 4,300 miles of canals, and a length of irrigating ditches estimated at 40,000 miles, costing from $10,000,000 to $12,000,000. These works are capable of irrigating about 2,200,000 acres of land. The total irrigable area of the State is estimated at 26,000,000 acres, all of which it is believed can be reached by means of reservoirs and other works of heroic magnitude. This area is nearly equal to the area of improved lands in farms in New York and in all the New England States combined. In no State or Territory has greater progress been made toward adjusting irrigating works to the social and buisness interests of the people than in Colorado.

Wyoming has already 5,000 miles of irrigating ditches, by means of which 2,000,000 acres of land have been reclaimed at a cost of several million dollars. The total irrigable area of Wyoming is estimated at 12,000,000 acres.

Idaho has about 1,400,000 acres of land under culture by means of irrigation, and it is estimated that there are 15,000,000 acres more in the valleys and uplands which may thus be made productive. It is believed, also, that by means of works of a heroic character fully 10,000,000 acres can be reclaimed in the valley of the Snake River alone.

Utah now has 3,000 miles of main canal and 8,000 of laterals, whereby 800,000 acres of land have been brought under cultivation. The cost of these works has been over $5,000,000. A contract has lately been concluded between interested parties for the construction of a canal 150 miles long, 10 feet deep, and 40 feet wide, from Bear Lake in Idaho Territory. This canal will irrigate 500,000 acres of land in Utah, and will cost about $4,000,000.

In Montana the range cattle industry and the mining industry have thus far been largely the leading interests, but agriculture through irrigation has acquired a firm foothold, and will perhaps have a larger development than in any other State or Territory. Already about 2,000 miles of irrigating canals and ditches have

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been constructed at an estimated cost of $1,620,000. The Yellowstone and the Missouri rivers have their principal sources and extend for many hundred miles in this Territory. The Yellowstone valley perhaps presents the largest and most valuable facilities for irrigation by means of hydraulic works without the necessity for enormous reservoirs, as the river supplies at once a conduit and abundant water power. In the Missouri valley will perhaps be located the most extensive irrigating works on this continent, rivalling, it may be, the great Ganges Canal of India, and perhaps approaching the great irrigating works of Babylonia and Arabia. By means of these works many million acres of land may be reached in Montana, Dakota, and perhaps even in Nebraska. It is believed that there are 8,000,000 acres of irrigable land in the Yellowstone valley alone, and 30,000,000 acres of irrigable land in the entire Territory of Montana.

Considerable progress has been made in irrigation in eastern Washington Territory, and very important results may be expected from the utilization of the waters of the Columbia, the Spokane, and the Snake rivers and their several branches. The State of Nevada is fully awake to the vital importance of irrigation, and her wishes are ably voiced by Senator Stewart, Chairman of the Senate Committee on Irrigation and Reclamation of Arid Lands, who states, in a recent magazine article, that the Humboldt valley for 300 miles is susceptible of reclamation, and that by a proper system of storage and canals 4,000,000 acres of land can be reclaimed. This is in excess of the farm area of the State of Massachusetts. Thus an agricultural population of more than 300,000 can be sustained. An area of several hundred thousand acres can also be reclaimed by storing and distributing the waters of Tahoe and Donner lakes, and their natural outlet, the Truckee river. It is also probable that noisome and pestilential basins of great magnitude, which now form the "sinks" of rivers in Nevada, and in various sections of the arid region, can be reclaimed by depriving them of the excess of water which now renders them barren, beside lands which are barren for lack of water.

The Territory of Dakota, by an act passed in 1881, adopted the doctrine of law favorable to the appropriation of water for beneficial uses, and the State Constitution of North Dakota recognizes

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the underlying principle of this doctrine, which is essential to the establishment of a system of irrigation. In Nebraska the value of irrigation and the possibilities which it opens up to agricultural development in the western portions of the State are fully understood. The geologist of the Agricultural Experiment Station of Nebraska declares that "irrigation can safely be relied upon to double the crops in western Nebraska." Several successful irrigating canals have already been constructed on the North Platte and its tributaries.

In western Kansas irrigating canals, whose aggregate length is 336 miles, have been constructed, whereby the waters of the Arkansas river are being utilized. These works have already reclaimed 300,000 acres of land, or greatly advanced its agricultural value. Other works are in course of construction.

WHAT THE NATIONAL GOVERNMENT HAS DONE AND CAN DO FOR IRRIGATION.

The United States Government has not yet adopted any comprehensive line of policy with reference to the reclamation of the agricultural lands of the arid region by means of irrigation, for the reason that the people of the country generally have not been sufficiently informed in regard to the subject in order to justify their representatives in taking such action. The first act of Congress having distinct reference to irrigation was passed March 3, 1877. It is commonly known as the "Desert Land Act." It provides that any citizen may secure the possession of 640 acres of desert land, *i. e.*, land which will not without irrigation produce an agricultural crop, by paying for it $1.25 per acre, and conducting water upon it. This act was framed for the purpose of disposing of arid lands to actual settlers, and of preventing speculators and large purchasers from taking up such lands in large tracts. It looked mainly to the utilization of the water of the smaller perennial streams for irrigation purposes. Experience has proved, however, that the Desert Land Act is well adapted to the requirements of the incipient stage of the great work of reclaiming the arid region. Under it the wonderful fertility of the lands of the arid region have been fully demonstrated, and the country has learned what may be confidently expected from works involving the resources of hydraulic engineering. This act is promotive of the interests of actual settlers, and it appears to

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form the proper basis for the land policy of the future throughout the arid region.

In 1879 the Chief of the Geological Survey published his invaluable report on "The Lands of the Arid Region," in which the possibilities of irrigation are clearly set forth. But it is only eighteen months since Congress took the first step toward the investigation of the subject in a manner looking to the thorough development of the agricultural resources of that vast area. A resolution of the Senate, adopted February 13, 1888, asked the Secretary of the Interior to inform that body if, in his opinion, it is desirable to segregate, *i. e.*, withdraw from entry, lands susceptible of irrigation, and to locate reservoirs, canals, and ditches on lands to be reserved for such purposes. The answer to this resolution is dated March 13, 1888. It was prepared by Major John W. Powell, Director of the Geological Survey, and recommends the adoption of the plan suggested by the Senate, both as to the segregation of lands and the location of reservoirs and canals. He also sketched the general features of a plan involving large engineering undertakings, such as the construction of extensive reservoirs and the utilization of the water of the larger streams and rivers, and earnestly advocated the adoption of such measures, upon considerations of an economic and commercial character. In his answers to the various inquiries by Congress, Major Powell showed that the work of the splendid branch of the Government over which he so ably presides has for the last ten years been directed with special reference to the reclamation of the arid region by means of irrigation, and that the results of that work now constitute an invaluable source of information upon which preliminary legislation may be based.

By joint resolution of March 20, 1888, the Director of the Geological Survey was directed to make examinations for the purpose of determining the practicability of constructing reservoirs for the storage of water, and preparing estimates of the cost thereof, and to report in relation thereto to Congress.

The act of October 2, 1888, making appropriations "for the sundry civil expenses of the Government," provided for surveys designed to furnish information covering the development of a general scheme for the reclamation of the arid region, and reserved from sale all lands susceptible of irrigation or which may

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be selected for reservoirs, canals, or ditches. One hundred thousand dollars was appropriated for this work. Soon surveying parties were sent to Montana, Nevada, Colorado, and New Mexico. The act making appropriations for "sundry civil expenses of the Government" for the year ending June 30, 1890, approved March 2, 1889, appropriated the further sum of $250,000 for the same purpose, and the surveys were correspondingly extended. Thus the important steps of technical examination and study have been taken, and in a manner becoming the magnitude and importance of the work. It is expected that the Director of the Geological Survey will be able to furnish to the Fifty-first Congress a large amount of valuable information, and to make recommendations touching the further progress of the work.

By resolution of February 14, 1889, the Senate appointed a Select Committee on "Irrigation and Reclamation of Arid Lands" composed of seven Senators. It is the duty of this Committee during the present recess of Congress to investigate the whole subject of irrigation in its economic, commercial, and political aspects, and for that purpose to visit the various parts of the arid region. This is now being done. Senator Stewart, of Nevada, chairman of this Committee, has for years given to the subject much careful study and reflection. In view of the fact that he represents a State greatly in need of irrigation, he will, in a peculiar manner, proceed in his work with "a mind illuminated by the sense of official responsibility." Besides, his large experience and distinguished ability as a statesman give promise of excellent results. The report of this Committee may be expected soon after Congress assembles in December. Thus the country has the promise of a flood of light upon the important subject of the reclamation of the arid region, and in all probability questions of practical legislation in regard to it will soon be submitted for consideration.

IMPORTANT CHARACTERISTICS OF THE ARID REGION.

For the purpose of establishing a general line of policy regarding the disposition of the public lands, the arid region may be considered under the following divisions: Agricultural lands, pasturage lands, and forests.

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The percentage of agricultural, of forest, and of pasturage lands in the arid region is approximately as follows:

Agricultural lands	18 per cent.
Forest land	18 per cent.
Pasturage land	64 per cent.
Total	100 per cent.

The agricultural lands are those which may be reclaimed by irrigation. The pasturage lands are those which are clothed with the peculiar indigenous grasses of the arid region, but cannot be irrigated. The forests of the arid region are situated mainly upon the high mountain slopes at elevations of from 6,500 to 12,500 feet above the level of the sea. The "timber line," or highest elevation at which trees grow, ranges from 10,000 feet at the North, to 12,500 feet at the South. It is said that forests do not grow where there is less than twenty-five inches of annual rainfall. In many parts of the arid region the irrigable lands are separated from the forest lands by wide intervening spaces of pasturage lands, but in the more mountainous portions the irrigable lands are contiguous, or nearly so, to the forest lands. The timber lands, owing to their elevation and their topographical features, are not available for agriculture, and therefore not desirable possessions under the Homestead, Pre-emption, or Desert Land laws of the United States.

Large portions of the pasturage lands are now too remote from water for pasturage purposes during the summer months. An extensive system of irrigation including artesian wells would render millions of acres of such lands available for pasturage at all seasons. At the present time it is impossible to make any estimate as to the lands absolutely desert, and other worthless lands, such as bald tops of snow-clad mountains, rocky wastes, &c. As the great bulk of the population of the arid region will undoubtedly be located within or near irrigable lands, the opinion extensively prevails that the rectangular system of surveys is not applicable to an economic and beneficial disposition of the pasturage and forest lands any more than it is to mineral lands. The question is an exceeding important one, and demands the earnest attention of Congress. Time and space forbid the discussion of the subject in this connection.

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A FUNDAMENTAL QUESTION OF LAW AND PUBLIC POLICY AFFECTING THE DEVELOPMENT OF THE ARID REGION.

Our ancestors brought with them to these shores the common law of England. The feature of that code known as "the law of riparian rights" is well adapted to a country where the rainfall is abundant but it presents an absolute legal barrier to the agricultural development of a country dependent upon irrigation. This law requires that running water shall flow in its natural channels, and thus reach every man's land "unimpaired in quality and undiminished in quantity." Irrigation involves the diversion of water into canals and ditches, which carry it to lands more or less remote from its natural channels. The right thus to divert water is based upon the rule of law known as "the dedication of water to beneficial uses." This rule is in direct antagonism to that of riparian rights. In all countries, ancient and modern, where irrigation has been successfully practised, the principle of "the dedication of water to beneficial uses" has been clearly recognized and enforced.

A long and obstinate warfare was waged in California as between riparian owners and "appropriators." This contest involved both civil and criminal proceedings and some social disorder. But the struggle has practically ended in the establishment of "appropriation for beneficial uses," as the rule of public policy best adapted to the development of the resources of the State. This rule may now be regarded as the common law of the arid region with respect to the disposition of water available for the purposes of irrigation. It has been incorporated into the provisions of the Desert Land Law, and it finds expression in Sections 2339 and 2340 of the Revised Statutes of the United States. It has also been distinctly affirmed by the Supreme Court of the United States as "the prevailing law wherever its beneficial application has been determined by local laws, customs, and decisions of the State and Territorial courts."

A vitally important feature of the law of appropriation for beneficial uses, is the doctrine that running water is the property of the State, and that the owners of irrigating canals are to be regarded simply as common carriers of water to the lands to be irrigated by it. This seems to have been the law of the ancients

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with respect to all proprietary conduits, and it is to-day the law of India, of Egypt, and of the countries of southern Europe. The Director of the Geological Survey has clearly and with great emphasis committed himself to the advocacy of this doctrine of the law of irrigation. It appears to be quite generally established as the law of the arid region, and it ought to become a cardinal feature of legislation by Congress for the reclamation of that area.

The laws of Wyoming in regard to irrigation furnish a model of wise legislation upon this subject. They provide, first, that all flowing water belongs to the public; second, that such water is dedicated to beneficial uses. Beneficial uses stand in the following order of preference: First, domestic use; second, irrigation; and third, manufacturing purposes. Priority of actual use for beneficial purposes gives the better right as between claimants. Every owner of an irrigating reservoir, canal, or ditch is considered to be a common carrier, and as such subject to the laws applicable to common carriers. The boards of water commissioners of the several counties are authorized to establish reasonable maximum rates for the use of water, and in contested cases the courts are empowered to prescribe the rates which shall be paid.

The recently adopted constitution of the State of Montana provides that "the use of all water now appropriated or that may hereafter be appropriated for sale, rental, distribution, or other beneficial use, and the right of way over the lands of others, shall be held to be a public use."

In Colorado the plan of the purchase of perpetual rights to the use of water is preferred to the rental plan. The evident tendency of the purchase plan is finally to throw the control of irrigating works into the hands of the land-owners who use the water.

Defects are continually coming into view, and practical difficulties are constantly arising in the administration of the irrigation laws of the several States and Territories, but experience is gradually dictating a policy and suggesting a code of laws adapted to the great variety of circumstances and conditions under which irrigation is practised in the various parts of the vast and diversified arid region.

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QUESTIONS OF PUBLIC POLICY INVOLVED.

One thing appears to be certain—the National Government is now confronted by the duty of taking the initiative in devising a general system for reclaiming the lands of the arid region. This duty is apparent in view of the national character of the work, its enormous magnitude, the power and function of the National Government, and the fact that to-day it holds in trust for the people of this country the title to fully eighty per cent. of the entire arid region. It remains for Congress, under the guidance of a well-formed and enlightened public sentiment, to consider the problems connected with the great question of irrigation, and if possible to solve them. It is certain that if the arid region is to be treated as boldly and as beneficially as the work of irrigation was treated by the Assyrians, the Babylonians, the Arabians, and the Egyptians in ancient times, and as heroically as it is now being treated by the British Government in India, the French Government in Africa, and by the nations of southern Europe, works of great magnitude must be contemplated whereby the waters of the larger rivers, such as the Columbia, the Snake, the Missouri, and the Yellowstone, can be utilized. Such works will, in certain instances, involve enormous reservoirs and canals of great capacity, sufficient for the supply of millions of acres of land. Besides, they must especially provide for the irrigation of lands which cannot be watered from the smaller streams. The canals of antiquity were constructed by national governments, and probably were administered by them, or under their supervision. This is also true of the great Ganges Canal of India and the principal canals of Egypt. In fact, wherever irrigation has been practised in a large way it has been done under the patronage and direction of some central government.

Accepting the theory of law that the owners of irrigating canals are to be regarded as common carriers of water, the question arises as to whether the larger movements of water between States shall become subject to regulation under the laws of the several States or of the United States.

FINANCIAL CONSIDERATIONS INVOLVED.

The financial considerations involved in the construction of the larger irrigating enterprises are exceedingly important. Fol-

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lowing the general line of financial policy in regard to the public lands which has prevailed from the beginning, it appears evident that the cost of the reclamation of the lands of the arid region must, in some way, come out of the proceeds from the sale of such lands; also that the National Government shall not seek to make such sales a source of net revenue.

The actual conduct of the work of construction suggests the following inquiry: Shall the larger canals be built by the National Government, or by States, or by private corporations? If the latter plan be adopted, to what extent shall the National and State Governments furnish financial aid? The following classification of works appears to be necessary in the adoption of a general scheme for the reclamation of the lands of the arid region:

First. The larger reservoirs with their canals perhaps extending into or through two or more States or Territories. The cost of such works will be very much in excess of the present financial ability of the particular States and Territories in which they may be located.

Second. Works of lesser magnitude entirely within the limits of single States or Territories.

Third. The smaller works serving towns, or even counties, the construction and management of which may be left to individual enterprise under State supervision.

If the States are to be charged with the duty of constructing reservoirs and irrigating canals on a plan and subject to conditions which will insure their construction, it is certain that a thorough and comprehensive scheme of reclamation, such as the present generation of men owe to posterity, will require such aid from the National Government as will afford to the States a substantial basis of credit upon which they can proceed at once with the work. Delay is rapidly increasing the difficulties which arise from obstructing vested interests and improvements whose condemnation will involve the exercise of the governmental attribute of eminent domain.

CERTAIN QUESTIONS OF POLICY AND OF ADMINISTRATION.

The harmonious and beneficent subdivision of political powers under our governmental system seems to suggest the general features of a satisfactory arrangement for the construction and

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management of the required works. The people of Wyoming are now considering the subject of irrigation under the following eminently practical heads:

First. Shall the National Government undertake the reclamation of the arid lands, and provide for their sale and settlement?

Second. Shall the "Desert Land Law" be so amended as to encourage individuals and companies to construct the necessary works for the reclamation of large bodies of land?

Third. Shall Congress grant to each State of the arid belt, or to each Territory upon its becoming a State, all the irrigable lands within its borders held by the National Government, such States to be charged with the supervision of their reclamation, and also with their disposal to actual settlers?

These inquiries, formulated by a conference of representative citizens of Wyoming, are engaging the earnest thought of the people of that Territory, with indications of a decided preference for the plan suggested by the last inquiry. While there appears to be a pretty general consensus of opinion among the people of the arid region that the larger works, or those involving the distribution of particular waters between the residents of different States is a matter which must be committed to the National Government, it also appears evident that the construction of works which have their beginnings and endings in particular States may well be committed to such States, together with the ownership of the lands to be irrigated thereby. This proposed line of policy has precedent in the donation of overflowed and swamp lands to the States, of which there have been patented about 57,099,762 acres. The governing physical conditions differ widely in the different States and Territories, and in different localities. This will involve a great variety of expedients for meeting varied requirements, and of course give rise to a large number of purely local questions in the administration of irrigating interests which the National Government cannot beneficially consider and determine.

Owing to the great size of the States and Territories of the arid region and the location of their boundary lines, it is probable that three-fourths or more of the total irrigable area may be served by reservoirs, canals, and ditches entirely within the limits of single States or Territories. The plan of departmental administration of irrigating work under a degree of central govern-

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mental supervision has been adopted in France. In Spain and in Italy it appears to be left to the provinces.

The predominant sentiment in this country in favor of local self-government in all matters immediately affecting the social and business interests of the people seems to point to the conclusion which will finally be reached in regard to this subject.

There is a question of constitutional law involved in the subject of irrigation which may here be alluded to. It is held that the water in the streams which are not navigable is subject to the jurisdiction of the States, whereas the land to be watered is owned by the Government, although it passes under the control of the State when sold to private parties. In view of this fact, Major Powell, Director of the Geological Survey, suggests that the lands to be reserved for reservoirs shall be ceded to the several States and Territories, under conditions which will insure the reclamation of arid lands under a general scheme of irrigation approved by Congress, and carried out under National supervision.

The idea appears to have taken deep hold upon the public mind in Colorado and Wyoming, that while in the beginning the State or Territorial Government must assert its control of all running water as the common property of the people, yet that the ownership and control of water rights, and the smaller irrigating works, must eventually be vested in the people who are to use such works, subject to the supervisory power of Government. This appears to be a plan especially adapted to the governing physical conditions of Colorado and Wyoming.

Governmental ownership and control now prevail with respect to the larger irrigating works in India, Egypt, and Italy, while the smaller works are owned and controlled by private corporations and individuals, but are subject to a somewhat rigid governmental supervision.

DISPOSITION OF CERTAIN PORTIONS OF THE PUBLIC LANDS.

By act of Congress dated March 3, 1879, a Public Land Commission was created. The persons appointed upon this Commission were especially qualified for the duties devolving upon them. Among the number were Major John W. Powell, Director of the United States Geological Survey, and Clarence King, Esq., United States Geologist. The preliminary report of the Commission,

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which was submitted February 25, 1880, was confined to recommendations of new legislation. One of the most important of its recommendations was that where a land grant to any railroad company embraces either irrigable or pasturage lands, the Secretary of the Interior shall be authorized, upon the application of the railroad company, and when, in his judgment, the public interests will be subserved thereby, to exchange sections bearing even numbers reserved by the Government for sections bearing odd numbers granted to the companies, so as to consolidate the lands held by the United States and by the companies in blocks of *not less than four contiguous sections, or* 2,560 *acres each.* It is believed that some such plan as this would enable both the Government and the railroad companies to dispose of their pasturage lands more advantageously and beneficially. At the rate of twelve acres of land to each head of cattle on the range—which is a fair average—2,560 acres of land would feed only 213 animals. It is probable, also, that blocks of 2,560 acres of irrigated land, or even larger bodies of land in single blocks, would much better serve the needs of colonies than blocks of 640 acres.

The second proposition to which attention is here invited is one which was advanced by Senator Stewart, of Nevada, in a speech delivered by him in the Senate February 9, 1887. The Senator proposes that the Pacific Railroad Companies which received subsidies in money from the Government shall be allowed and encouraged, under proper safeguards, to cancel their obligations to the Government, now amounting to about $100,000,000, by expending this amount in irrigating works and in constructing branch lines which may be necessary to reach the land thus reclaimed. This recommendation, made by Senator Stewart with the object in view of developing the resources of the arid region, and especially of the State which he represents in Congress, seems to be worthy of careful consideration. It is not yet known whether the consent of the companies can or cannot be secured to the proposed plan. The consideration which would actuate the Government in entering into such an arrangement would be that it owes to the country, to posterity, and to civilization the duty not only of initiating, but, to the full limit of its function, of aiding in the reclamation of the vast agricultural resources of the arid region. This will involve the expenditure of a large

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amount of money. The Pacific railroads also owe a certain sum to the Government. The practical question for Congress then to consider is, "shall this debt be diverted toward the discharge of the obligation now resting upon the Government to do its full share toward reclaiming the arid region?" A resolution which was adopted by the Senate March 2, 1889, among other things instructed the select committee, to which was referred that portion of the President's Message which relates to the indebtedness of the Pacific railroads, to inquire "how the indebtedness of said companies can be so adjusted and paid as to advance the development of the country through which said roads pass." Presumably this refers to the proposition above referred to. Senator Frye, of Maine, is chairman of that committee, and it may be taken for granted that the duty will be performed ably and thoroughly, and with a full appreciation of the importance of the development of the arid region.

While it appears to be a duty of the hour that the preliminary steps toward a comprehensive policy shall now be taken in regard to the reclamation of the lands of the arid region of the United States, it also appears evident that, in order to reach a definite plan of action which shall deal with the whole subject understandingly and beneficially, it ought to be referred to a commission composed of specialists in regard to the legal, economic, commercial, and engineering features of the enterprise, and that this commission shall be required to give their undivided time and attention to the subject for a period of time sufficient in order to enable them to consider it in all its complex and varied aspects.

RELATIVE VALUE OF THE ARID REGION AND LANDS DEPENDENT UPON RAINFALL.

There is a popular impression among people living east of the 100th meridian that the cost of agricultural production is greater in the arid region than within the limits of the "rain-belt." This is an error which should at once and forever be dispelled from the public mind. The writer of this article was summarily undeceived upon this point by a Montana farmer, whose prompt reply to an assertion as to the greater cost of irrigation was this: "Irrigation is cheaper than the natural rainfall." This appar-

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ently paradoxical reply was explained thus: "At the East you have a crop of corn which is suffering from drought. If no rain comes you will have, say, only half a crop. The value of a full crop will be, say, fifty bushels of shelled corn at fifty cents per bushel, $25. The loss of half of this is $12.50. What would you give for a sufficient supply of water to secure a maximum, crop? Certainly $10 an acre. But we can get it by irrigation for $2 an acre." In a word, irrigation insures a crop every year, or two crops each year, to the full capability of the soil, and eliminates the most distressing feature of farming in the East—the uncertainties due to droughts and an excessive amount of rainfall. Again, the different crops need different quantities of water and at different times. The rainfall treats all alike. But the farmer who irrigates learns the needs of the different crops, as he learns the habits of his domestic animals.

There is, however, a third particular in which the irrigated lands of the arid region are superior to the lands of the "rain-belt." The heavens supply to vegetation two aliments essential to life and growth—water and sunshine. The direct rays of the sun are as essential to plant growth as water. The advantage which the arid region enjoys in this respect is indicated by the fact that there is an annual average of 3,810 hours of sunshine in New Mexico, 2,671 hours at New York City, and 1,121 hours at London. Owing to its elevation the arid region also has about one-fifth less atmospheric air to obstruct the sun's rays. The greater size and weight, and the superior flavor of the fruits of Southern California are due to the fact that they enjoy during their growth more sunshine than fruits which grow in the "rain-belt." The standard weight of oats per bushel at the East is 32 pounds; but in the arid region, under culture by irrigation, their weight runs up to from 38 to 48 pounds per bushel.

There is still another and very important advantage in irrigation. The waters which descend from the mountains bear a valuable fertilizing silt which penetrates to every part of the soil and enriches the whole uniformly. This fertilizing property of the water of irrigation is observable by every practical farmer. Senator Stewart, of Nevada, declared in his speech delivered in the Senate February 9, 1889: "Forty acres of land properly irrigated anywhere in the arid region will support a family as well as 160

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acres in a region cultivated by rainfall." Others say one acre in the arid region is worth two in the "rain-belt." Such testimony is abundantly confirmed by the experiences of farmers in every State and Territory of the arid region.

The soil of the arid region, of course, varies very much in fertility, but as a rule it is stronger than the soil of the "rain-belt." It has also the peculiar quickness of all virgin soils. The farmers of that section who have previously tilled the soil in the "rain-belt," declare that the irrigated lands of the arid region are preferable even to those rich soils of our Northwestern States, of which it has so often been said that they "need only to be tickled with a hoe, that they may laugh with a harvest."

THE CLIMATOLOGY OF THE ARID REGION.

The limited amount of rainfall upon the agricultural lands of the arid region is mainly due to meteorological conditions imposed by mountain ranges. The prevailing winds of that portion of the United States which lies west of the Rocky Mountains, and to a considerable extent, of the area east of that "divide," are southwest winds, which come from the Pacific Ocean. In approaching our shores these winds pass over the Kuro Siwa, or warm Japan current—the "Gulf Stream of the Pacific"—and thus become heavily charged with moisture. As they reach our shores they hold in suspension an amount of humidity which, if equally distributed, would be sufficient to water all the lands of the area over which they blow. But the uniformity of the rainfall is broken by great mountain ranges. This is easily explained. The atmosphere diminishes rapidly in density from the earth's surface upward. One-half its entire weight or volume is within 18,480 feet, or $3\frac{1}{2}$ miles, of the sea level. Again, half the entire moisture in the air is within 6,500 feet, or $1\frac{1}{4}$ miles, of the sea level. Now the diminution of density caused by elevation produces a reduction of temperature, and reduction of temperature causes a rapid reduction in the capacity of air to hold moisture. As the warm, moisture-laden winds from the Pacific Ocean strike our Western shores and pass over the continent they are repeatedly tossed upward by mountain ranges whose average elevation is from 6,000 to 15,000 feet. These ranges—the Coast range and the several Rocky Mountain ranges and groups—thus compel a

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very large precipitation from the moisture-laden winds, while the intermediate valleys and plateaus on either side of the great "divide" receive very little moisture. The average annual rainfall on the mountains is from 35 to 75 inches, while on the lower lands it is only from 5 to 15 inches annually. At least 28 inches annually is necessary for successful agriculture.

Similar meteorological conditions have produced the aridity of lands in other countries, and in all ages human ingenuity and enterprise have been taxed to their utmost in the task of "fighting the desert with water." It remains to be seen whether we have or have not the requisite ingenuity, enterprise, patriotism, and courage to equal, or perhaps excel the achievements of those nations long since departed, which we feel compelled to regard as our inferiors in science and in art.

The various conditions which affect the productiveness of the earth's surface, viz., quality of soil, elevation, topographical features, and latitude, produce widely different agricultural results. The quality of the water brought down from the mountain sides also affects plant-life differently. So throughout our vast arid region, which in an intense degree displays all this variety of conditions, we must expect to see wide differences in the results of the applied art of irrigation.

There is in some quarters of the West a popular belief that the rain-belt or humid area is moving westward. This is attributed to various causes. Some think it is the result of laying railroad tracks in an east and west direction; others that it is due to the influence of telegraph wires, while others attribute it to an increased amount of evaporation from the cultivated lands of the Western and Northwestern States. A gentleman of some distinction attributes it to a sympathetic relation between the earth and man's moral, intellectual, and spiritual advancement, and in this view predicts that oranges will some day grow in Alaska. It is undoubtedly true that lands which a few years ago were believed to be too dry for culture are now yielding good crops after being plowed. This appears to be due mainly to the fact that a large part of the rainfall which formerly ran off the hard surface of the land into the streams is now absorbed by the soil. So the fact appears to stand beyond all question that the limit of the area which may be cultivated without irrigation is from 200 to 300 miles farther west than it was formerly supposed to be.

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FORESTS IN THEIR RELATION TO IRRIGATION.

There is, and has been for a long time, an earnest discussion of the question as to whether forests do or do not influence the rainfall. These who hold to the latter opinion point to the fact that the Pilgrim Fathers planted themselves upon the eastern shore of the most extensive forest on the earth, with the Atlantic Ocean on the other side of them, and yet within four years from the time when they landed at Plymouth Rock they observed a day of fasting and prayer on account of a terrible drought, which solemnity was repeated twenty-three times within a hundred years. It is, however, a fact beyond dispute that forests on the sides of the mountains throughout the arid region do perform a very important function in the general scheme of irrigation, by protecting the snows from the direct rays of the sun, thus preventing them from melting before they can be utilized as storage reservoirs during the season of crop growth. In this connection may be mentioned the proposition, which appears to be perfectly practical, that the smaller mountain streams shall be diverted, during the winter months, into shaded ravines and chasms so as to form large masses of ice—small glaciers—the melting of which will be slower even than that of snow on the exposed mountain sides. To a certain extent this may become a very useful mode of storing water for irrigation. The snow and ice on the lofty mountain summits now furnish, by their gradual melting, an abundant supply of water in Utah and in other parts of the arid region during the entire irrigating season.

TEMPERATURE AND HEALTHFULNESS OF THE ARID REGION.

There are three physical conditions which mainly determine the average annual temperature and the seasonal differences of temperature of different localities throughout the arid region. First, the fact that it has a range of 17 deg. 30 min. of latitude; second, the fact that its western border is warmed by the Kuro Siwa, or Japan current, while its eastern border has the cooler continental climate of the interior; and third, differences of elevation, each 600 feet of elevation having about the same effect upon temperature as one degree, or 69½ statute miles, of latitude. These differences of physical conditions involve marked local dif-

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ferences both of temperature and humidity. Elevation also determines the density or pressure of the atmosphere. These are the chief atmospheric conditions which determine the comfort and healthfulness of animal life. Generally it may be said that there is no more healthful portion of the globe than the arid region of the United States. Its climate appears to possess that peculiar elasticity of temper which is promotive of the development of brain and brawn alike.

In the higher altitudes, where the air is very light and dry, nasal catarrh affects certain persons, and such localities are also unfavorable to persons afflicted with certain diseases of the heart. There is an endemic disorder known as "mountain fever" to which certain persons are subject. But a residence in the arid region produces an almost certain cure of pulmonary diseases not too far developed, and malarial troubles are there almost unknown. During the winter months there is sometimes a fog which rests over the Salt Lake valley called by the Indians, Po-go-nip. It is said to cause pneumonia in children, if due care is not taken to prevent their undue exposure to its influences, but it is not regarded as of any serious consequence as a condition of the healthfulness of that locality.

TRANSPORTATION INTERESTS OF THE ARID REGION.

Thirty years ago the project of constructing a railroad across the continent was regarded by many as chimerical. The cost of transportation by rail was at that time ten to twenty times what it is to-day. It then appeared certain that the low rates of transportation by the Panama route and the Cape Horn route would confine the railroad traffic mainly to first-class passengers, the mails, and express packages. It was also believed that the receipts from local traffic would be largely exceeded by the expenditures which would be involved in protecting the line and its through traffic against the Indians and the Mormons; for the Government had then (1859) just put down a Mormon rebellion, which had cost the country over $30,000,000. Many more overland emigrants had been robbed and murdered by Mormons than by Indians. It is probable that a large majority of the civil engineers and practical railroad builders of the country who at that time believed that it was possible to build a transcontinental rail-

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road, nevertheless, would have condemned the project as a commercial enterprise, and for valid reasons. But the great war for the preservation of the national life came, and a Pacific railroad was seen to be a political necessity. It was built, and its construction stands, with the abolition of slavery and the establishment of American nationality upon a firmer foundation, to the glory of the statesmen of that day.

The Pacific railroad of the war period not only served the political purpose for which it was constructed, but it has been the *avant courier* and promoting cause of a development which will in a few years be expressed in eight or ten populous States of the Union.

Already the country has many times over been remunerated for the aid it extended to the Pacific railroad companies in lands and in money, by the appreciated value of the remaining public lands, by the saving effected in the cost of transporting Government officers, employés, and supplies, and the United States mails, and by the development of a knowledge of the resources of the arid region. This has resulted in a large railroad expansion. The total length of the first Pacific railroad from Omaha to San Francisco is 1,867 miles, but to-day there are within the limits of the arid region more than 17,000 miles of railroad track, forming six or seven independent and sharply competing transcontinental lines.

These railroads are now sustained mainly by local traffic, which has followed the development of the pastoral, agricultural, and mineral resources of the arid region, and by the general commerce which has followed in the train of railroad construction. This is clearly illustrated by the following data, showing the through and local traffic of the Union Pacific* and the Northern Pacific Railroads.

NORTHERN PACIFIC RAILROAD, 1889.

	Tons carried.	*Receipts.*
Through Freight.....	210,368,299	$2,271,824
Local Freight.....	664,412,934	10,231,449

*For the special purpose of illustration here had in view, "Local," "Through," and "Commercial Freight" of the Union Pacific Railway Company have been taken as constituting "Local Freight," and "Pacific Coast Freight" as alone constituting Through or Transcontinental Freight.

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UNION PACIFIC RAILROAD, 1888.

	Tons carried one mile.	*Receipts.*
Through Freight.....	426,501,166	$3,944,202
Local Freight.....	705,174,234	9,332,229

While the country has not yet begun to comprehend the magnitude of the development which waits upon irrigation, railroad enterprise is not only abreast of the new movement, but somewhat in advance of it. The Northern Pacific, the Chicago, Milwaukee & St. Paul, the Chicago & Northwestern, the Union Pacific, the Central Pacific, the Southern Pacific, the Chicago, Burlington & Quincy, the Chicago, Rock Island & Pacific, the Atchison, Topeka & Santa Fé, and other railroad companies are constructing new lines and forming new commercial connections whereby they may be the better enabled to secure the traffic results of future settlement and development. In this struggle for the traffic of the future, these corporations are now supplying facilities considerably in advance of the present demands of commerce and of productive enterprise. Rates of transportation throughout the arid region are effectually regulated and determined, not only by such competition between the railroad companies themselves, but also by the interaction of commercial and industrial forces operating through the railroads and created by them.

It is one of the marvels of this wondrous age that mainly through the commercial facilities afforded by railroad transportation this branch of "Uncle Sam's Farm," the great arid region, only a few years ago segregated to the use of wandering Indians, has been perfectly subdued to the arts of peace, and that it is today closely associated with the commercial activities of the world.

MINERAL RESOURCES OF THE ARID REGION.

It is impossible to present here anything more than a very general survey of the vast mineral resources of this portion of "Uncle Sam's Farm." These resources, in connection with the agricultural possibilities of the arid region, will form the integral parts of a highly-organized, prosperous, and substantial industry, the development of the various parts of which will be along the

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line of their interdependent commercial relationships and largely the result thereof:

Gold and Silver.—The value of the gold and silver product of the United States is greater than that of any other country on the globe. It is two and one-fourth times that of Mexico, the country whose product is next to that of the United States in the order of magnitude. Thirty-three per cent. of the world's product of gold and forty-two per cent. of its product of silver is the yield of mining in the United States. The silver product of this country in 1887 was $33,136,000, and the gold product $53,941,800. Practically this entire yield of the precious metals—over ninety-nine per cent. of it—was the product of the arid region, for the gold of California, $13,400,000, and the silver of that State, $1,500,000, was from mines within the limits of the arid region. This total value of precious metals, $87,000,000, was almost entirely the product of labor in some form. The earth presents opportunities to mankind while the hand of labor coins them into values. Probably this product, $87,000,000, furnished a market for products of agriculture to the value of at least $35,000,000, almost all the yield of the soil of the arid region through irrigation. Aside from the monetary value of gold and silver in the finance of the world's commerce, the production of these metals has an exceedingly important relation to the industrial development of the arid region, and, as such, has a forceful claim upom the protective care of the National Government.

Coal.—The arid region abounds in coal of excellent quality. Its total yield in 1887 was about 2,000,000 tons. The deposits of coal fully developed in Wyoming could supply the world for an indefinite period. In a certain locality—the Rock Springs mines—the supply is estimated at 25,000,000 tons to the square mile. Anthracite coal has been found in Colorado and New Mexico, and excellent coking coal in Wyoming. Extensive beds of cannel coal, from fifteen to twenty feet thick, yielding oil abundantly, have also been discovered in Wyoming.

Petroleum.—The petroleum field of Wyoming, probably extending into Montana, is more extensive than that of New York and Pennsylvania combined, and at points where tapped yields abundantly. Natural gas has also been discovered in the same region and probably exists in great volume.

Lead.—The total lead product of the United States during the year 1887 was 160,700 tons, valued at $14,463,000, of which ninety-four per cent. was the product of the arid region. The supply of ore is inexhaustible. About eighty per cent. of the entire quantity of lead produced in this country is the joint product of silver and lead mining.

Copper.—The total copper product of the United States during the year 1887 was 92,335 tons, valued at $21,052,440, of which

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fifty-five per cent. was the product of the arid region. The supply of copper in that region is inexhaustible.

Iron.—Iron abounds throughout the entire Rocky Mountain region, and ores of excellent Bessemer steel quality are found in inexhaustible quantities.

Salt, sulphate, and carbonate of soda, and a large number of other useful metals and minerals are also found in various parts of the arid region, and in practically inexhaustible quantities.

Such is the character of this portion of "Uncle Sam's Farm," its soil and its subterranean resources. It is a field "white unto harvest." The quickening influence of irrigation in the development of agricultural lands will stimulate enterprise to active effort in every branch of human industry.

THE INDIAN AS A TENANT OF UNCLE SAM'S FARM.

The Indian never was a proprietor of the soil, and to the present day he scorns the idea of property in the soil. Land ownership is an affront to the barbarian. The Indian right to the use of land in common was not acquired by purchase or negotiation, or by any just proceeding, but always through wars inspired by the lust of conquest. Thus, as the centuries rolled by, one powerful tribe after another acquired dominion over particular tracts of territory in the absence of any sort of right which could establish a just title to it. The white race, on the other hand, has acquired the title to land on this continent through negotiation and by purchase, except as the result of wars resulting from savage assaults upon the progress of civilization. From the beginning, the white race has done a thousand times as much for the comfort, the security, and the advancement of the Indian, as the Indian has done for himself.

That part of "Uncle Sam's Farm" which we are now considering—the great arid region—was until about thirty years ago practically sequestered to the use of the Indians of this country as a common hunting-ground. When the Cherokees were located in the Indian Territory in 1838, a strip of land sixty miles wide and two hundred and twenty miles long, adjacent to the State of Kansas was granted to that tribe, as an "outlet" or highway to this vast field of savage sport. No person then supposed that this vast area would or could be appropriated to any better use. From

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that time onward, the Indians generally were permitted to leave their reservations and to spend the summer months in the arid region, but when the value of this area for pastoral purposes was discovered, the buffalo, the elk, and the moose retired before the millions of horses, cattle, and sheep which took their places, and the Texas cowboy became the presiding genius of this vast domain. Thus the Indian was held close corralled upon his reservation by a force of circumstances which forever marked the end of his nomadic career. Now the "granger" is supplanting the herdsman throughout the arid region, and the idea appears to have fairly dawned upon the people of this country that civilization has the right of way to the future on this continent.

As now circumstanced the Indian has lost even that claim to respect which he inspired as a manly and self-sustained barbarian, for he is fast sinking into the degradation of pauperism. Segregated from the examples and the influences of civilization, his pride and prejudice impels him to starve sooner than till the soil. Says the Rocky Mountain chieftain to his people: "The earth is your mother, to scratch her bosom with a plow is to insult her;" and in the sullen spirit of discontent begotten of idleness, the Indian daily loses his self-respect while eating the bread of charity, which is invariably destructive of the very fibre of manhood in Indian and white man alike.

The total Indian population of the United States, including that of the Indian Territory, is now 246,036, and they occupy 108,389,469 acres of land. This provides 440 acres to every Indian man, woman, and child. Practically this is waste land, although every 160 acres of it is amply sufficient for the support of a civilized family. The hopelessness of converting the Indian into an agriculturist by the reservation plan is becoming more and more apparent, and it seems also to be certain that he will never become a worker, or a useful member of society, until, under proper protection, he is brought closely in contact with the influences of civilized life, and until he has ceased to be a mere encumberer of a large and fair portion of the national domain, which in the course of a few years will be reclaimed by the art of irrigation.

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CONCLUSION.

The subjugation of the lands of the arid region to the uses of civilized man implies very much, and it promises very much. It summons the nation at once to an opportunity and a duty. The magnitude and importance of the work, and the evident need of devising a broad and comprehensive plan of reclamation at the earliest practicable moment, mark the present time as an epoch in the history of the country. A generation which saved the life of this nation by an enormous sacrifice of human life and a vast expenditure of money is passing away, and upon the generation immediately following devolves the heroic task of providing for a large expansion of the national resources. The example of the nations of antiquity piques us to endeavor, and upon us rests the obligation of the Divine mandate—"Subdue the earth." To doubt that this great duty will be performed manfully and effectually, would be to impeach the patriotism and intelligence of the present generation of men.

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